

ON THE ANATOMY OF CERTAIN SPECIES OF *SILIQUA* AND *ENSIS*.

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Read 11th November, 1904.

PLATE XII.

I WISH, first of all, to express my indebtedness to Professor W. H. Dall, of the United States National Museum, for his kindness in permitting me to examine the following specimens.

1. *SILIQUA PATULA* (Dixon).*External Characters.*

The animal is straight along the dorsal surface, with the exception of a slight ventral deflection about one-third of the distance from the anterior end. The length from the anterior side of the anterior adductor muscle to the posterior side of the proximal portion of the siphon is 60 mm., and the depth at the anterior and posterior ends 27 mm.

The mantle-lobes commence at the postero-dorsal surface of the anterior adductor muscle, and, in passing anteriorly over it, are quite separate from each other. Then they take a deep curve, and proceed posteriorly about half-way along the ventral surface, when they become coneresced, so that the pedal aperture is a large opening extending from the anterior adductor muscle to the point of conerescence. Further, near the centre of the ventral surface, the mantle-lobes have the appearance of being abruptly pressed in, and of gradually resuming their normal condition as they pass anteriorly. Around the whole of the edge of each mantle-lobe is a curious foliated fringe. At the anterior end of the pedal aperture it is inconspicuous, but, proceeding along the ventral surface, it increases in size, and, near the centre, assumes a larger and more complicated arrangement. At the posterior end it is again very small, and becomes larger as it traverses anteriorly the dorsal surface. The muscular flaps bordering the pedal aperture are weak.

The siphon is deep and comparatively short. The proximal portion is very muscular, while the anterior part of each lateral side terminates in a powerful siphonal retractor muscle. The free portion of the siphon is in one piece, the exhalent being separated from the inhalent chamber by a very muscular wall. This divisional wall extends to the anterior end of the proximal portion of the siphon. The distal end of each siphonal chamber is bordered by a tentacular fringe, with the tentacles more numerous at the dorsal and ventral edges of the siphon, and the remaining portion of the siphon is covered with a papillose integument. There is no fourth aperture.

The gills are relatively short and deep. They lie well dorsally, and reach as far as the wall dividing the siphonal chambers. The outer

demi-branches begin more posteriorly than the inner ones. The exterior edges at the bases of the gills are connected with the siphonal wall, and the interior ones are joined together. The labial palps are short at the base, and form a long taper to the distal ends.

Musculature.

1. *Pallial Muscles.*—The muscles of each mantle-lobe commence over the anterior adductor muscle as a shallow band, and deepen as they proceed to the ventral surface, along which they form a band of considerable yet varying depth.

The muscles of the proximal portion of the siphon are very strongly developed, and terminate anteriorly in extremely powerful siphonal retractor muscles. Inside each mantle-lobe, a short distance dorsal to the line of concrescence, is a muscular ridge (Fig. 1, *P.R.*). This ridge continues along the proximal portion of the siphon as far as the siphonal retractor muscle. Its function is not apparent.

The anterior adductor muscle (Fig. 1, *A.A.*) is a narrow and deep muscular plate, widening towards the ventral surface. Posteriorly it rests against the clavicle or rib of the shell. Dorsally and anteriorly it is connected with the mantle-lobes, and posteriorly with the dorsal and ventral integuments.

The posterior adductor muscle (Fig. 1, *P.A.*) is an oval plate of muscles. On the antero-dorsal surface rest the distal parts of the bifurcations of the retractor posterior muscle. Dorsally the muscle is connected with the dorsal integument, and ventrally with the ventral integument.

2. *Pedal Muscles.*—Though a portion of the distal end (Fig. 1, *R.F.*) is missing, the general structure of the foot appears to be very similar to that of *Solen*.

The muscles apparently coinciding with the protractor pedis anterior muscles are short and powerful. They pass anteriorly alongside the viscera. Laterally they are attached to the valves of the shell, while anteriorly they are joined to the dorsal and ventral integuments. The fibres pass over the longitudinal muscles of the foot (that is, they are exposed to the pedal cavity), and spread out as they proceed ventrally.

The retractor pedis posterior muscle (Fig. 1, *P.R.P.*) is of medium length, the distal end is bifurcated, and the bifurcations rest on the posterior adductor muscle. The fibres of the muscle pass anteriorly along the foot as longitudinal muscles.

The retractor pedis anterior muscles are situated at the antero-dorsal part of the foot. The free portions run dorsally close to the liver, and are attached to the shell. The fibres on reaching the foot pass partly into the pedal integument, and partly along the fibres of the retractor pedis anterior muscles.

Alimentary Canal.

The lips (Figs. 2 and 3, *A.L.* and *P.L.*) are broad and thick. The œsophagus (Figs. 2 and 3, *Oe.*) is long, and proceeds with a curve in a dorso-posterior direction to the œsophageal division of the stomach

(Figs. 2 and 3, *Oe.St.*). The latter is neither deep nor long, but very wide. The central division (Fig. 2, *C.D.*) is deep, and bordered by a muscular ridge. Dorsally the œsophageal and central divisions are completely separated from the cardiac division (Figs. 2 and 3, *C.St.*) by a muscular wall (Figs. 2 and 3, *Oe.C.R.*) stretching laterally across the stomach. The posterior portion of this divisional wall, which also forms the dorsal limit of the central division, is very strongly developed. The cardiac division projects anteriorly a little over the œsophagus and extends posteriorly to the pyloric division (Figs. 2 and 3, *P.St.*), from which it is likewise separated by a muscular ridge (Fig. 2, *M.R.C.*). The pyloric division (Figs. 2 and 3, *P.St.*) is large, and irregular in shape. On the ventral side, at the posterior end, it continues as the cæcum of the crystalline style (Figs. 1, 2, and 3, *C.C.*). The latter is also large, of considerable length, and passes with a curve towards the dorsal surface of the pedal cavity.

The intestine (Fig. 1, *In.*) leaves the stomach anteriorly to the cæcum of the crystalline style. After forming, in and on the liver, a number of loops, it passes to the distal end of the cæcum and returns some distance along its ventral surface, when, becoming free, it proceeds to the dorsal surface of the pyloric division. Turning posteriorly, it continues as the rectum, is soon encircled by the ventricle, and, passing over the posterior adductor muscle to the exhalant chamber, terminates at the bilobed anus.

The liver is large, and covers the stomach, with the exception of the posterior end. The mass of it, however, lies ventrally to the stomach.

Nervous System.

The cerebro-pleural ganglia are wide apart, anterior, although near to the retractor pedis anterior muscles, and are joined by a commissure passing in front of the mouth. Each ganglion apparently gives rise anteriorly to only one nerve, which innervates the anterior adductor muscle and the mantle-lobes. Posteriorly each ganglion is connected with a pedal ganglion, but it is not possible to locate the exact position of the latter in the specimen examined. Each cerebro-pleural ganglion is also joined with one of the visceroparietal ganglia by a connective running between the viscera and lateral integument, then underneath the bifurcated parts of the retractor pedis posterior muscle to the ganglion.

The visceroparietal ganglia are situated between the bifurcations of the retractor pedis posterior muscle. Each ganglion gives off laterally a branchial nerve, and only one posterior nerve, viz. the posterior pallial nerve. It innervates the posterior adductor muscle, the siphon, and the mantle-lobes.

Gills.

A transverse section, cut horizontally to the axis of the demi-branch (Fig. 4), shows it to belong to the type homorhabdic, also to be non-plicate, and consequently not presenting any differentiation of the filaments. The interlamellar junctions are not regularly situated, the number of filaments between them varying considerably and ranging from 10 to 24.

2. SILIQUA COSTATA (Say).

Siliqua costata is very similar to *S. patula*, the chief differences discernible being: (1) the groove in which rests the clavicle or rib of the shell runs a little more antero-ventrally than in *S. patula*, so that the anterior adductor muscle of *S. costata* is forced a little anterodorsally; (2) the large pallial fringe at the middle of the ventral surface is proportionately longer and narrower, and has a dendritic appearance; (3) the free portion of the siphon is smaller, while the exterior border between it and proximal portion of the siphon is more pronounced, this being particularly so at the dorsal and ventral surfaces. It may, however, be partly due to contraction. No material difference is noticeable in the internal structure.

3. ENSIS DIRECTUS (Conrad).

Ensis directus closely resembles *E. ensis*, but is more massive and deeper. Both sides of the posterior end of the proximal portion of the siphon curve outwards instead of inwards. The free portions of the siphon are more prominent, and carry a denser mass of tentacular fringe. The fourth aperture is more central, that is, it is nearer the anterior end. It is also longer, and bordered by several rows of tentacles.

There is no appreciable difference in the internal structure.

4. ENSIS MINOR, Dall.

Ensis minor also closely resembles *E. ensis*, but is very much smaller and more attenuated. It curves more dorsally, and the fourth aperture is situated at the centre of the ventral surface.

There is no marked difference in the internal structure.

EXPLANATION OF PLATE XII.

Siliqua patula (Dixon).

- FIG. 1.—View from the right side, showing the alimentary canal, etc. Natural size.
 ,, 2.—Longitudinal section of the stomach, showing internal structure of the left side. $\times 1\frac{1}{2}$.
 ,, 3.—Longitudinal section of the stomach, showing internal structure of the right side. $\times 1\frac{1}{2}$.
 ,, 4.—Transverse section of the gill, cut horizontally to the axis of the demi-branch. $\times 60$.

REFERENCE LETTERS.

A. anus; *A.A.* anterior adductor muscle; *A.L.* anterior or upper lip; *B.V.* blood-vessel; *C.* chitin in interfilamentar junction; *C.C.* cecum of the crystalline style; *C.S.* crystalline style; *C.St.* cardiac division of the stomach; *C.D.* central division of the stomach; *Ex.S.* proximal portion of the exhalant siphonal chamber; *Ex.S'* free portion of the exhalant siphonal chamber; *F.* foot; *I.J.* interlamellar junction; *In.* intestine; *In.S.* proximal portion of the inhalant siphonal chamber; *In.S'* free portion of the inhalant siphonal chamber; *I.S.* interlamellar septum; *L.* liver; *M.* mouth; *M.R.C.* muscular ridge separating the cardiac from the pyloric division of the stomach; *M.R.P.* muscular ridge separating the central from the pyloric division of the stomach; *Oe.* oesophagus; *Oe.C.R.* ridge dividing the oesophageal from the cardiac division of the stomach; *Oe.St.* oesophageal division of the stomach; *P.A.* posterior adductor muscle; *P.L.* posterior or lower lip; *P.R.* pallial ridge; *P.R.P.* retractor pedis posterior muscle; *P.St.* pyloric division of the stomach; *R.* rectum; *R.F.* restored portion of the foot; *S.R.* ridge dividing the inhalant from the exhalant chamber of the proximal portion of the siphon; *St.* stomach; *T.P.M.* transverse pedal muscles; *V.* ventricle.